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Effects of buck and doe size on the growth performance and survival of their progeny

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Abstract

This study on the effects of paternal and maternal goat size on kid growth and survival was conducted by grouping bucks and does into big/elite and small/control categories and mating between the sub-groups to create four progeny groups whose body weight and mortality rate were assessed for fixed and variable effects at birth, 10, 20, and 30 weeks of age.

Big sized bucks and does had progeny that were heavier than those of small sized parents at all ages except at birth. The mean body weight of the progeny at 30 weeks was 15.1±0.6 kg for elite bucks and 13.2±0.8 kg for control bucks. Due to sexual dimorphism, male progeny were heavier than their female counterparts at birth, 20 weeks and at 30 weeks. Birth type had the most profound effect on both live weight and survival of goats. Single kids weighed 2.2 ± 0.05 kg at birth compared to 2.0± 0.03 kg for twins, and the margin of superiority widened to 3.5 kg at 30 weeks. Over 85% of the kids that died between birth and 30 weeks were born as a twin which effectively negated the advantage that is normally thought of for twinning in such a goat flock.

It is concluded that paternal and maternal size influences the weight of progeny at birth and through to maturity. Birth type and sex of kids also have profound effects on kid weight as well as on survival. However, the advantage of elite parentage appears to get diminished unless diet improvements are incorporated. In general, using elite bucks does have potential financial benefits for Mubende goat farmers.

Keywords

goats, maternal effect, Mubende breed, selection, sire effect

Disciplines

Agriculture | Animal Sciences

Comments

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Effects of buck and doe size on the growth performance and survival of their progeny

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Abstract

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Introduction

Livestock production is increasingly being driven by a shift in diet and increased food consumption of livestock products (FAO 2013). Over the past few decades, most of this shift has been observed in developing countries (Mugisha et al 2009). Goats, by their nature, continue to be of potential in many areas but are usually not targeted by livestock research for development. Small ruminants, like goats, should be the animals considered for small farms in developing countries due to their small size, ease to be fed, housed and treated when sick. Their small size also makes it easier for households to slaughter and consume piece meal without worry for prolonged meat preservation as is the case for bigger livestock species.

In 2010, out of the world's two billion sheep and goats, over one third was in Africa and one half in Asia (FAO 2013). Despite these population statistics, the actual consumption of meat in the developing world is still very low and the predicted livestock revolution (Delgado et al 1999) may not materialize at the level predicted due in part to the private sector not supporting the opportunity to increase livestock production. To meet the continuously increasing demand for both milk and meat in the developing countries, improvement in livestock productivity is still very much needed. Such improvements could be realized through a combination of improved husbandry and careful utilization of the existing livestock genotypes (Philipsson et al 2006), including both selection within breeds and orderly/planned crossbreeding. Selection only works where there is variation, and the wider the variation, then the more likely that selection will succeed.

Phenotypic variation in a population is a result of a number of factors such as the individuals' genotype, environment, or an interaction between the two (Plomin et al 1977). The environment may influence an individual's phenotype directly or through environmental effects associated with its mother (Rossiter 1996). These environmental effects on the offspring are a result of the dam's genotype for traits like milk production, and are usually as a result of the environment experienced by the dam (Freeman et al 2013). Among other effects, maternal nutrition plays a critical role in foetal growth and development in most livestock species (Wu et al 2004). This study was conceived, after observing that among the Mubende goats (Photos 1 and 2), a wide variation in weight/size exists between goats of the same age and that there is a financial advantage to smallholders in rearing bigger goats. This means if big bucks and does could produce faster growing progeny than their smaller counterparts, it would make economic sense for farmers to invest in bigger bucks and/or bigger does. Therefore, the objective of this research was to determine the effect of paternal and maternal body size of Mubende goats on growth and survival of their progeny.

Materials and Methods

Study site

The experiment was conducted at the Makerere University farm (0^{o} 28′N, 32^{o} 37′E), located 20 km north of Kampala City in Uganda, at an altitude of 1250 m at the highest point and 1185 m in the valley bottoms. The annual rainfall is about 1300 mm for an average of 150 rain days. The wet season includes a broad peak in March to May and a narrow peak in October to November; the wettest months being April (+200 mm) and November (+180 mm).

Photo 1: A flock of Mubende goats outside their night housing (D R Kugonza)

Photo 2: A big Mubende buck (D R Kugonza)

Experimental Animals

Sixty does and six bucks were selected from a goat flock of 100 goats, excluding pregnant, lactating and goats with compromised health. Using chest girth and live body weight, the goats were grouped into big size (elite) and small size (control) (Table 1). Three elite bucks were mated to 15 elite does and 15 control does, while three control bucks were mated to 15 elite does and 15 control does. The mean chest girth of the does at mating was 78.4 ± 0.7 cm (elite does) and 72.2 ± 0.6 cm (control does); while the live weights were 35.9 ± 0.6 kg (elite does) and 28.4 ± 0.4 kg (control does). For the bucks, the mean chest girth at mating was 81.4 ± 0.4 cm (elite) and 67.8 ± 0.4 cm (control); while the live weights were 41.6 ± 0.2 kg (elite) and 26.6 ± 0.3 kg (control). A total of 75 kids were born; 20 single, 26 sets of twins and one set of triplets.

Table 1: Categories of goats used in the study

Goat category	Level	Number of goats	Live weight (kg)	Chest girth (cm)
Elite/Big	Elite Buck (EB)	3	>40	>80
	Elite Doe (ED)	30	>33	>76
Control/Small	Control Buck (CB)	3	<35	<78
	Control Doe (CD)	30	<32	<76

Housing and holding system

All the goats were managed under the semi-intensive system in which housing was basically for overnight occupation by the various goat groups while most of the day time was spent outdoors. Does and weaned goats were kept overnight in raised and slatted floor pens with an average floor space of 1.5 square meters per mature doe and one square meter per weaned goat. Lactating mothers were housed in ground-level slatted floor pens with over 3/4 of the walls covered to avoid draughts. The rest of the houses had walls made of timber boards, with wire mesh covering the upper 1.5 m of the walls. Bucks were housed in a permanent house with wooden slats floor. A yard of 9 m × 15 m constructed with a concrete floor was used as a mating area for the goats.

Feeding and health management

Does and weaned kids were grazed daily on open pasture. The predominant grass species were Guinea grass (*Panicum maximum*), Rhodes grass (*Chloris gayana*), Foxtail (*Setaria anceps),* Star grass (*Cynodon dactylon*), and Signal grass (*Brachiaria brizantha)*. A fenced paddock measuring 40 m × 50 m near the holding/housing unit was used for late afternoon/evening grazing. Bucks were usually tethered on good pasture and sometimes allowed to graze in the paddocks. The grazing of both does and bucks was occasionally supplemented with fresh leguminous fodder of *Leucaena leucocephala* and *Gliricidia sepium*. Water was provided ad libitum to the goats in the holding/collecting yard. Mineral salt licks were given fortnightly.

All goats were provided with treatment as and when they showed signs of sickness. Predominant diseases encountered included diarrhea (scours) and pneumonia in kids; mange and wounds in mature goats. Worm and fluke infestation was also recorded especially in the rainy season. Drenching with anthelmintics was done bi-monthly in the mature herd, and monthly among kids and weaned kids (weaners). Other less frequent health problems encountered included foot rot and milk fever. Bi-weekly spraying of the goats with acaricides ensured control of ecto-parasites like ticks, lice and fleas.

Data collection

Kid weights were taken using a 20 kg range Salter® scale, before 0800 hour, taking care to avoid weighing them after suckling or after exposure to other feed. Each kid was individually placed in a polyethylene bag which was suspended onto the scale. Measurements were taken weekly starting at birth until 52 weeks of age.

Data analysis

Simple means and ranges were computed across the entire data set and by each class variable to identify data entry errors. Data were subjected to analysis of variance using PROC MIXED procedure of SAS Ver. 9.2 (SAS 2012). The model used included buck size category (Elite or Control), doe size category (Elite or Control), birth type (single or twin), the interaction between buck and doe size classification, and sex of kid were included in the model as fixed effects and doe number was included as a random effect. Least square means for each level of all fixed effect classifications were estimated. The dependent variables evaluated included kid birth weight, 10-week body weight, 20-week body weight and 30-week body weight. Not all animals were represented at each weight point due to mortalities that occurred. Mortality records (alive or dead at end of 30 weeks) were recorded and analyzed using only simple descriptive statistics because of the limited information available for these traits.

Results

Big sized bucks sired kids that were not different (P>0.10) in birth weight from those of control sized bucks (Table 2). However, the elite buck effect was significant (P<0.01) at 10 weeks and tended towards significance (P<0.10) at subsequent ages. Kids mothered by elite does followed a trend similar to that of their counterparts sired by elite bucks. Birth weight of kids was significantly influenced (P<0.01) by their sex and birth type. Male kids were superior (P<0.01) to females at birth and at all post-weaning ages. The effect of birth type was the most intense in this study, with single kids weighing significantly (P<0.01) more than twins at birth, 10 weeks, 20 weeks and 30 weeks.

Table 2: Means of kid body weight from birth to 30 weeks as affected by buck size, doe size, sex and birth type

	Kid live body weight (kg) at various ages			
Effect	Birth	10 weeks	20 weeks	30 weeks

Buck size	Elite	2.1±0.03	7.5±0.2	11.2±0.5	15.1±0.6
	Control	2.1±0.04	6.3±0.3	9.7±0.6	13.2±0.8
		p>0.10	*p<0.01*	*p<0.10*	*p<0.10*
Doe size	Elite	2.1±0.04	7.3±0.3	11.2±0.4	15.1±0.6
	Control	2.1±0.03	6.6±0.2	9.7±0.5	13.2±0.7
		p>0.10	*p<0.10*	*p<0.10*	*p<0.05*
Sex	Male	2.2±0.03	7.1±0.2	11.1±0.4	15.0±0.6
	Female	2.0±0.04	6.7±0.3	9.9±0.4	13.3±0.6
		p<0.01	*p>0.10*	*p<0.01*	*p<0.05*
Birth Type	Single	2.2±0.05	8.1±0.3	12.1±0.5	15.9±0.7
	Twin	2.0±0.03	5.8±0.2	8.9±0.5	12.4±0.6
		p<0.01	*p<0.01*	*p<0.01*	*p<0.01*

A total of 28 kids (37.3%) had died by the age of 30 weeks. The mortalities occurring up to 30 weeks of age may have been influenced by doe size, with 75% of the mortalities being for kids born to control does, while only 25% were by elite does. Only 42.9% of the dead kids were sired by elite bucks, and 57.1% of kid mortalities were sired by control bucks. A combination of small-sized parents caused 46.4% of the mortalities while only 14.3% of the mortalities resulted from mating both big-sized bucks and does. The mating of elite does to control bucks resulted in less kid mortality (10.7%) than when control does were mated to elite bucks (28.6%). Most of the kids that died (57.1%) were male. A greater proportion (85.7%) of the kid mortalities were born as one of twin kids, while only 14.3% of them were born as a single kid. While kid mortality was not evaluated in depth, the trends identified using simple statistics are suggestive to the impacts from differing buck and doe size.

Discussion

It is important for this discussion to understand that the purpose of this study was to investigate the role that parental body size, litter size and kid sex has on growth performance of Mubende goat progeny. Mubende goats are one of the four goat breeds in Uganda. Considering their relatively big adult body size (Semakula et al 2010) and national flock size, it is the breed that should be contributing most to the goat meat consumed in the country. It is therefore imperative that performance of this breed is enhanced and this study was conducted so as to contribute to that enhancement. Awareness of how breeds and breed combinations compare for economically important kid traits from birth to weaning allows for diversity present to be exploited by proper breed selection (Browning and Leite-Browning 2011). In this study, focus was on the diversity in body weight of mature Mubende goats such that if a genetic basis of size is determined, selection could be promoted.

Buck and doe size effects on progeny growth were significant or tended towards significance over the 30 week period (probably ranges from P<0.01 to P<0.10). This observed superiority can be explained by the concept of genetic size and growth in goats (Ogink 1993). Accordingly, genetic size is expressed during the developmental stages of growth and it peaks in the mature animal. Offspring from Elite does were not different at birth however, at 10 and 20 weeks they tended to be heavier (P<0.10), and at 30 weeks were heavier (P<0.05) when compared to offspring from control does. As showed in Table 2, sex and birth status (single/twin) were significantly important effects at 30 weeks (P<0.05), with males showing superiority over females; while single kids grew faster than twins throughout the study period.

The mean birth weight of Mubende goats in this study (2.1 kg) is close to previous studies showing 2.0 kg (Oluka 1999), but much higher than 1.22 kg (Okello 1993). Birth weight is an economic trait, which has a positive relation with kid survival and overall post-natal development. The heritability estimate of birth weight in goats ranges between 1.5% and 46% (Roy et al 1989; Das et al 1996).For the reason that these values are low to medium, genetic progress in improvement of meat production through selection procedures based on birth weight is relatively feasible. Birth weight is an indicator of the rate of fetal growth, itself regulated by genetic, epigenetic and environmental factors (Ashworth 2013). These factors influence placental growth and functionality, and ultimately, the maternal uterine environment particularly size and efficiency of the placenta. Within a given breed, birth weight depends on the weight of the parents and especially the adult dam weight (Berhanu et al 1991) and its age (Das 1993; Browning and Leite-Browning 2011).

Male kids were superior (P<0.01) to females due to the effects of sexual-size dimorphism (Shine 1989; Liao et al 2013) which is widely observed in the animal kingdom, appearing commonly in domesticated as well as wild species. In domestic mammals, human control replaces sexual selection that is found and plays the dominant role in the wild mammals (Fairbairn 1997; Zhang and Lu 2013). In wild mountain goats, the inheritance pattern of this unique attribute has been extensively studied (Mainguy et al 2009), and shows that superiority in size is actually genetic. In the current study, more male kids (1.33) died per female kid, implying that sex could have been of influence on survival, as was found in goats elsewhere (Perez-Razo et al 1998).

Birth weight decreased as litter size increased (Table 2), with single kids growing much faster than twins at all ages. The relationship between single and multiple births has also been documented with other breeds such as Boer, Kiko, and Spanish (Browning and Leite-Browning 2011). Indeed, while the weight differential between single and twins in the current study was 0.2 kg at birth and 2.3 kg at 70 days, it was 0.4 kg at birth and 2.9 kg at 90 days in Boer and Spanish goats (Browning and Leite-Browning 2011). A life-history trade-off between offspring number and size has recently been documented (Schroderus et al. 2012) and apparently, the heritability of litter size is low in most litter producing livestock such as goats (Menendez-Buxadera et al 2003), rabbits (Rastogi et al 2000) and swine (Holl and Robison 2003).The superiority of the singles' live weight over twins could be explained by the higher nutrient uptake per kid expected for singly born kids. It is probable that single kids consume more colostrum and hence more immunoglobulins than twins or triplets. This means that resistance to disease is stronger in singles and hence the higher possibility of a better growth rate, live body weight. This should also explain why the mortality ratio between singles and twin over the 30 weeks studied was 1: 6. According to Robinson et al (1977), as the number of fetuses in utero increase, the number of caruncles attached to each fetus reduces. This therefore reduces the nutrient uptake for offspring raised in big litters. Elsewhere, litter size and parity were found to be responsible for 28% of the variation in birth weight in West African Dwarf goats and a bigger 46% of the variation in Saanen goats (Ogink 1993).

Mortality of goat kids has been shown to be associated with birth month, litter size at birth and dam age (Browning and Leite-Browning 2011). Mortality rates have been shown in previous research to decrease as litter size increases while on the other hand; sex of kid did not influence pre-weaning survival (Browning and Leite-Browning 2011). In our study, the goat flock showed a characteristic low pre-weaning mortality rate of 13.3%, compared to 17.0% (Okello 1993), and 20.3% (Oluka 1999) who also worked with the Mubende breed. Boer goats raised in Uganda were found to have a mortality rate of 11%, and a similar value was documented for the Small East African goats (Nsubuga 1996). Work done by Sacker and Trail (1966) and Wilson (1982) reported that mortality rates among Ugandan goats are characteristically lower than those reported for other African studies. This could be a factor of disease adaptation and not necessarily health management as may be surmised.

Of particular concern is the question of whether the variation between progeny of the two parental groups could have been broader if the diet, which was limited to naturally existing pasture grasses, sparse legumes, and occasional legume fodder, had been supplemented with more dietary protein. The probable answer is positive. The adverse environmental conditions under which indigenous animals are reared have for many years limited the attempts to improve livestock productivity in most developing countries in the tropics (Katule 1991) and when this is coupled with low genetic potential, the situation does not get better. Clearly the overriding question is, will improved genetics express themselves without improved feeding and other environmental conditions? The response according to our findings is negative.

Implications of these findings are that smallholder farmers must determine the value of buying improved (elite) bucks at increased costs. Considering that an elite buck cost $100, while small bucks cost $60 and that when selling goats, farmers receive about$2.5 per kilogram of weight; using an elite buck at a mating ratio of 1:30 would produce at least 50 animals in the flock. This would potentially increase the flock off take per annum by $340. Clearly, it would offset the $40 price differential between elite and control bucks.

Conclusion

- Paternal and maternal size does influence weight of progeny at birth and at subsequent ages. Birth type and sex of kids also have profound effects on kid weight. However, the advantage for producers to use elite parentage is not completely realized through increased kid weight. This may be the result of inadequate nutritional resources for both the dam to produce sufficient milk and the offspring to reach their genetic potential for increased weight gain.

Recommendations

The following recommendations have been formulated for ensuring increased growth performance of Mubende goats:

- Big bucks should be promoted for use in goat breeding since they show genetic elitism

- Improving post-weaning diets of goats is pertinent so as to actualize the growth superiority resulting from use of elite sires and dams.

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Go to top